

CLAIMS

What is claimed is:

1. A process for recognizing a digital image using a computer and an ABM algorithm, where ABM is the "Attrasoft Boltzmann Machine", which further consists of the ABM training algorithm and the ABM recognition algorithm, said ABM training algorithm comprises:

Imposing an image to an ABM so the ABM will be trained, whereas the ABM is a specific combination of (a) a fully connected neural network and (b) a Markov chain;

Classifying at least one target image based on the invariant distribution function of the trained ABM wherein the step of Imposing an image to an ABM further comprises:

- a) deleting existing ABM connections;
- b) creating an input vector, p , based on an input image, x , and its classification, y ;
- c) breaking the input vector, p , into a number of pieces, p_1, p_2, p_3, \dots , where such breaking could either be logically based on objects/segments or geometrically;
- d) constructing a set of neural state vectors, s_1, s_2, s_3, \dots according to p_1, p_2, p_3, \dots , whereas a state vector, s_1 , has a number of 0's (grounded state) and a number of 1's (excited state); all such vectors together form a configuration space, $H(P)$;
- e) computing an initial neural connection from each of p_1, p_2, p_3, \dots , said computation comprising:

e1) constructing a connection space, $H(C)$, where each neural connection is a point inside this space;

e2) making the connection space, $H(C)$, from a configuration space, $H(C) = (H(P), R)$, where R is a space of real numbers;

e3) making an initial connection $c1$ to be $c1 = (p1, 1)$, or $f(p1) = 1$, where $f(p1)$ is a connection matrix element;

f) computing the rest of the neural connections from each of the initial connections, $c1, c2, c3, \dots$, said computation comprising:

f1) constructing a distance or distances, $d(p1, p1')$, between an initial neural state, $p1$, and an arbitrary state, $p1'$; said distances can be Hausdorff distance, or L1 distance, or L2 distance, or any other distances;

f2) constructing a function, $g(d)$, which maps a distance between two neural vectors, d , to a number, $g(d)$; said function comprising of any functions as long as it decreases in value when the distance increases;

f3) constructing an arbitrary connection element $(p1', g(d(p1, p1')))$ from the initial connection element;

f4) applying $(p1', g(d(p1, p1')))$ for all points in the connection space since the ABM is a fully connected network with all possible ranks.

g) constructing an ABM Markov chain after all of the connections are established.

2. The process of Claim 50, wherein the step of Classifying at least one target image based on the invariant distribution function of the trained ABM comprises:

- a) imposing an image to be classified on an ABM Markov chain;
- b) allowing the ABM Markov chain to settle on its invariant distribution, described by a distribution function;
- c) classifying the target image based on this invariant distribution function, said distribution comprising of information of classes and weight given by the invariant distribution function directly;
- d) presenting the results as a triplet (image, classification, weight), which can be used both in image search and image classification.

3. A process for recognizing a digital image using a computer and an APN algorithm, where APN is “Attrasoft PolyNet”, an extension of the ABM, which further consists of the APN training algorithm and the APN recognition algorithm, said APN training algorithm comprises:

Imposing an image to an APN so the APN will be trained, whereas the APN is a specific combination of (a) a fully connected neural network, (b) a Markov chain, and (c) a mapping function (called the APN function);

Classifying at least one target image based on the invariant distribution function of the trained APN wherein the step of Imposing an image to an APN further comprises:

- a) deleting existing APN connections;
- b) creating an input vector, p , based on an input image, x , and its classification, y ;
- c) breaking the input vector, p , into a number of pieces, $p_1, p_2, p_3 \dots$, where such breaking could either be logically based on objects/segments or geometrically;
- d) constructing a set of neural state vectors, $s_1, s_2, s_3 \dots$ according to $p_1, p_2, p_3 \dots$, whereas a state vector, s_1 , has a number of 0's (grounded state) and a number of 1's (excited state); all such vectors together form a configuration space, $H(P)$;
- e) computing an initial neural connection from each of $p_1, p_2, p_3 \dots$, said computation comprising:
 - e1) constructing a connection space, $H(C)$, where each neural connection is a point inside this space;
 - e2) making the connection space, $H(C)$, from a configuration space, $H(C) = (H(P), R)$, where R is a space of real numbers;
 - e3) making an initial connection c_1 to be $c_1 = (p_1, 1)$, or $f(p_1) = 1$, where $f(p_1)$ is a connection matrix element;
- f) computing the rest of the neural connections from each of the initial connections, $c_1, c_2, c_3 \dots$, said computation comprising:

f1) constructing a distance or distances, $d(p1, p1')$, between an initial neural state, $p1$, and an arbitrary state, $p1'$; said distances can be Hausdorff distance, or L1 distance, or L2 distance, or any other distances;

f2) constructing a function, $g(d)$, which maps a distance between two neural vectors, d , to a number, $g(d)$; said function comprising of any functions as long as it decreases in value when the distance increases;

f3) constructing an arbitrary connection element $(p1', g(d(p1, p1')))$ from the initial connection element;

f4) applying $(p1', g(d(p1, p1')))$ for all points in the connection space since the APN is a fully connected network with all possible ranks;

g) constructing an APN Markov chain after all of the connections are established;

h) constructing an initial mapping to reflect the contribution of the multi-valued neurons; said mapping comprising of pairs: (neuron position, input vector value);

i) constructing the rest of the mappings based on the initial mapping; said mapping comprising of pairs: (neuron position, input vector value in the initial mapping).

4. The process of Claim 53, wherein the step of Classifying at least one target image based on the invariant distribution function of the trained APN comprises:

a) imposing an image to be classified on an APN Markov chain;

b) allowing the APN Markov chain to settle on its invariant distribution, described by a distribution function;

- c) classifying the target image based on this invariant distribution function; said distribution comprising of information of classes and weight given by the invariant distribution function directly;
- d) constructing intermediate results as a triplet (image, classification, weight);
- e) computing a new weight, said computation comprising:
 - e1) constructing a distance between two mappings, the mapping associated with the image to be classified and the mapping associated with a connection;
 - e2) constructing a function (called the APN function): $\text{weight}' = h(\text{weight}, d)$; said function, h , comprising of any functions as long as it decreases in value when the distance, d , increases;
 - e3) modifying the old weight by this function;
- f) constructing results as a triplet (image, classification, weight'), which can be used both in image search and image classification.

Appendix A. Accompanying Application Document and CD

1. Two CD's Labeled "Document, Sample Implementation"

A. The disks contain only three **ASCII** files.

B. Each disk in the duplicate set is identical.

C. CONTENTS OF THE CD:

File Name	Type	Size	Date	Description
ABM4_9	TXT	156,256	05-16-02	Detailed description of ImageFinder 4.9
ABM5_0	TXT	96,515	05-16-02	Detailed description of PolyApplet 5.0
ABM5_1	TXT	43,019	05-16-02	Detailed description of TransApplet 5.1

D. These documents are Copyrighted:

ImageFinder 4.9: TX 5-385-330

PolyApplet 5.0: Pending

TransApplet 5.1: Pending

E. Interpretation: These three files will give detailed descriptions of the three sample implementations:

Detailed description of ImageFinder 4.9

Detailed description of PolyApplet 5.0

Detailed description of TransApplet 5.1

2. Two copies of the coil bound manual labeled "User's Guide, Attrasoft ImageFinder 4.9".

These are two hard copies of the User's Guide for Attrasoft ImageFinder 4.9.

3. Two CD's Labeled "Attrasoft ImageFinder 4.9"

A. The disks contain only **non-ASCII** files. The CD contains two types of files:

(A1) Installation file, which will install the following executable files to a computer with Microsoft Windows as the operating system:

- Attrasoft ImageFinder 4.9 for Windows 95/98/ME, execution files;
- Attrasoft ImageFinder 4.9 for Windows 2000/XP, execution files;
- Data File for running the software;
- User's Guide in Microsoft Word, and
- User's Guide in html format.

(A2) A set of executable files running from the CD with Microsoft Windows as the operating system:

- Attrasoft ImageFinder 4.9 for Windows 95/98/ME, execution files;
- Attrasoft ImageFinder 4.9 for Windows 2000/XP, execution files;
- Data File for running the software;
- User's Guide in Microsoft Word, and
- User's Guide in html format.

B. The Operating System is Windows 95, 98, ME, 2000, and XP.

C. Each disk in the duplicate set is identical.

D. CONTENTS OF THE CD:

Not all contents are listed, because there are too many files. The two data directories, for example, contain more than 80,000 files. The Date information is not accurate due to the date setting of the computer, which creates these files.

Root Directory Contents:

File Name	Type	Size	Date	Description
DISK1	ID	5	01-05-90 9:31p	Installation File
DISK10	ID	5	01-05-90 9:31p	Installation File
DISK11	ID	5	01-05-90 9:31p	Installation File
DISK12	ID	5	01-05-90 9:31p	Installation File
DISK13	ID	5	01-05-90 9:32p	Installation File
DISK14	ID	5	01-05-90 9:32p	Installation File
DISK2	ID	5	01-05-90 9:32p	Installation File
DISK3	ID	5	01-05-90 9:32p	Installation File
DISK4	ID	5	01-05-90 9:33p	Installation File
DISK5	ID	5	01-05-90 9:33p	Installation File
DISK6	ID	5	01-05-90 9:33p	Installation File
DISK7	ID	5	01-05-90 9:33p	Installation File
DISK8	ID	5	01-05-90 9:34p	Installation File
DISK9	ID	5	01-05-90 9:34p	Installation File
SETUP	EXE	47,616	01-05-90 9:31p	Installation File
SETUP	INI	32	01-05-90 9:31p	Installation File
SETUP	INS	147,449	01-05-90 9:31p	Installation File

SETUP	ISS	510	01-05-90 9:31p	Installation File
SETUP	PKG	15,061	01-05-90 9:31p	Installation File
INST32I	EX	306,666	01-05-90 9:31p	Installation File
_ISDEL	EXE	8,192	01-05-90 9:31p	Installation File
_SETUP	1	721,623	01-05-90 9:31p	Installation File
_SETUP	10	1,454,681	01-05-90 9:31p	Installation File
_SETUP	11	1,455,574	01-05-90 9:31p	Installation File
_SETUP	12	1,455,468	01-05-90 9:31p	Installation File
_SETUP	13	1,454,113	01-05-90 9:32p	Installation File
_SETUP	14	1,074,165	01-05-90 9:32p	Installation File
_SETUP	2	1,454,796	01-05-90 9:32p	Installation File
_SETUP	3	1,456,887	01-05-90 9:32p	Installation File
_SETUP	4	1,455,245	01-05-90 9:33p	Installation File
_SETUP	5	1,455,918	01-05-90 9:33p	Installation File
_SETUP	6	1,455,206	01-05-90 9:33p	Installation File
_SETUP	7	1,453,720	01-05-90 9:33p	Installation File
_SETUP	8	1,455,603	01-05-90 9:34p	Installation File
_SETUP	9	1,456,571	01-05-90 9:34p	Installation File
_SETUP	DLL	10,752	01-05-90 9:31p	Installation File
_SETUP	LIB	196,219	01-05-90 9:31p	Installation File
ABM49	<DIR>		06-08-01 1:04p	Executable File
USPTO72	<DIR>		02-28-01 7:15p	Data File
USPTO74	<DIR>		05-21-01 4:33p	Data File

E. Interpretation of the files

(E1) Files labeled “Installation File” are used to install the following executable files to a computer with Microsoft Windows as the operating system:

- Attrasoft ImageFinder 4.9 for Windows 95/98/ME, execution files;
- Attrasoft ImageFinder 4.9 for Windows 2000/XP, execution files;
- Data File for running the software;
- User’s Guide in Microsoft Word, and
- User’s Guide in html format.

To install the software to a Personal Computer using Windows, double click the setup.exe file.

(E2) The directories, labeled “Data”, contain the data files to run the software. There are more than 80,000 files in the two directories, so they will not be listed.

(E3) The directories, labeled “Executable”, contain the executable file to run from the CD.

Directory Contents:

File Name	Type	Size	Date	Description
50X50	<DIR>		06-08-01 1:04p	Data File
ABM49_2K	EXE	385,536	06-08-01 11:54a	Executable
ABM_A1	BMP	25,182	08-31-99 11:02p	Executable
DEISL1	ISU	47,058	06-08-01 1:05p	Executable
IMAGEF~7	<DIR>		06-08-01 1:04p	Data File
_ISREG32	DLL	24,576	02-07-96 8:07a	Executable
ABM48	TXT	79	06-08-01 12:26p	Executable
ABM48_1	TXT	6	03-23-01 9:20a	Executable

ABM48_2	TXT	6	03-23-01 9:21a	Executable
ABM48_3	TXT	6	03-23-01 9:21a	Executable
ABM48_4	TXT	6	03-13-01 2:28p	Executable
ABM48_5	TXT	6	03-13-01 2:28p	Executable
ABM48_6	TXT	6	03-13-01 2:28p	Executable
ABM48_7	TXT	6	03-13-01 2:28p	Executable
ABM48_8	TXT	6	03-13-01 2:29p	Executable
ABM48_9	TXT	6	03-13-01 2:29p	Executable
ABM49	EXE	386,048	06-08-01 10:53a	Executable
ABM4_9	DOC	3,598,336	06-07-01 10:52a	User's Guide, Word
FBI	<DIR>		06-08-01 1:04p	Data File
FINAL	<DIR>		06-08-01 1:04p	Data File
HELP	<DIR>		06-08-01 1:04p	User's Guide, html
LOCK_~15	<DIR>		6-08-01 1:04p	Data File
LOCK_~17	<DIR>		06-08-01 1:04p	Data File
NOTES	TXT	140	03-23-01 10:33a	Executable
OBLIQUE	<DIR>		06-08-01 1:04p	Data File
STAMP	<DIR>		06-08-01 1:04p	Data File
USPTO	<DIR>		06-08-01 1:04p	Data File

The interpretation of this subdirectory:

- The directories, labeled "Data", contain the data files to run the software.

- The directory, labeled “User’s Guide, html”, contains the user’s guide files in html format.
- The file, labeled “User’s Guide, Word”, contains the user’s guide files in html format.
- The files, labeled “Executable”, contain the executable files for Windows 95/98/ME/200/XP.

4. Two copies of the coil bound manual labeled “User’s Guide, Attrasoft TransApplet 5.1”

These are two hard copies of the User’s Guide for Attrasoft TransApplet 5.1.

5. Two CD’s Labeled “Attrasoft TransApplet 5.1”

A. The disks contain only **non-ASCII** files. The CD contains the following files:

- Attrasoft TransApplet 5.1 software library for Windows 95/98/ME/2000/XP, COM/DLL file format;
- Sample Implementation Codes;
- User’s Guide in Microsoft Word, and
- User’s Guide in html format.

B. The Operating System is Windows 95, 98, ME, 2000, and XP.

C. Each disk in the duplicate set is identical.

D. CONTENTS OF THE CD:

Root Directory Contents:

File Name	Type	Size	Date	Description
ABM5_1	DOC	616,448	10-21-01 11:28a	User’s Guide, Word

CHAP3	<DIR>		10-19-01 4:31p	Examples
CHAP4	<DIR>		10-19-01 4:31p	Examples
CHAP5	<DIR>		10-19-01 4:31p	Examples
CHAP6	<DIR>		10-19-01 4:31p	Examples
CHAP7	<DIR>		10-19-01 4:32p	Examples
FBI	<DIR>		06-08-01 1:04p	Examples
HELP	<DIR>		10-19-01 4:40p	User's Guide, Word
OBLIQUE	<DIR>		06-08-01 1:04p	Examples
README	TXT	567	10-20-01 10:51a	readme.txt
TRANS~26	DLL	282,112	0-21-01 11:00a	COM DLL

E. Interpretation of the files

(E1) The file labeled "COM DLL" is the COM DLL software library file to be used by users.

(E2) The directories, labeled "Examples", contain the examples of how to use the COM DLL.

(E3) The files, labeled "User's Guide, Word" and the directory, "User's Guide, html", contain the User's Guide.

6. Inventor's Resume'.